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AIRMAN APPLICANT PREDICTION SYSTEM (AAPS): THEORY AND RESULTS

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The objective of this research effort was to design a model(s) to estimate the impact of key demographic variables on individual and group accession behavior. This would provide personnel managers the ability to project the quality mix of future accessions and track the impact of this quality mix on enlisted retention behavior as these accessions advance through a military career. Six demographic groups were analyzed: males, females, Caucasians, Blacks, others, and all. Within each demographic group, four aptitude groups were studied: Armed Forces Qualifying Test (AFQT) Categories I's, II's, IIIa's, and IIIb's. The results of the modeling and estimation effort were implemented into the Airman Applicant Prediction System (AAPS) to predict the number of applicants from selected demographic/aptitude groups. The estimated equations were used to predict the proportion of a Military Available (MA) population which would be interested in applying to the Air Force (by AFQT Category). AAPS proceeds through a series of steps to arrive at population numbers for Interested Qualified Military Available (IQMA). IQMA can then be disaggregated through the AAPS software to determine from the IQMA population who would potentially meet mechanical, administrative, general, and electronic (MAGE) minimum Armed Services Vocational Aptitude Battery (ASVAB) composite score requirements.

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PREFACE

This research and development effort was conducted as task order 49 under Contract F41689-88-D-0251 (SBA 68822004) by Metrica, Inc. for the Manpower and Personnel Research Division of the Armstrong Laboratory, Human Resources Directorate (AL/HR). The purpose of this effort was to design a model to estimate the impact of key demographic variables on individual and group accession behavior which directly impact the retention of enlisted personnel in the Air Force.

The authors wish to thank Mr Vincent Wiggins and Mrs LeAnn Coleman for their valuable technical contributions to this effort. In addition, the authors would like to express appreciation to Ms Barbara Randall (computer programmer), Mr Kevin Borden (computer programmer), and Mr Darryl Hand (computer programmer).

AIRMAN APPLICANT PREDICTION SYSTEM (AAPS): THEORY AND RESULTS

SUMMARY

The objective of this research effort was to design a model(s) to estimate the impact of key demographic variables on individual and group accession behavior. The demographic factors of the supply model were gender, race, and geographic location (state). In addition, the analysis investigated the propensity of Armed Forces Qualifying Test (AFQT) categories I, II, IIIa, and IIIb to apply for Air Force service.

The analysis used pooled time series, cross-sectional (state level) data extracted from the historical Military Entrance Processing Stations (MEPS) data combined with population data from the Bureau of the Census; earnings and employment data from the Bureau of Labor Statistics (BLS); and data on production recruiters, numbers in the Delayed Entry Program (DEP), and recruiting goals from Air Force Recruiting Service. Twenty equations were estimated, one for each demographic and aptitude group. The equations were estimated using monthly data from January 1983 to December 1989. The out-of-sample credibility of the esti ed equations was validated using data from January 1990 to December 1990.

The results of the modeling effort were implemented into the Airman Applicant Prediction System (AAPS), a user-friendly, menu-driven, PC software package which predicts the flow of selected demographic groups into the Air Force from an available population. The estimated equations can be used to predict the proportion of a Military Available population which will be interested in applying to the Air Force (by AFQT category). AAPS proceeds through a series of steps to arrive at population numbers for Interested Qualified Military Available (IQMA). IQMA can then be disaggregated through the AAPS software to determine the number of the IQMA population who would potentially meet mechanical, administrative, general, and electronic (MAGE) minimum Armed Forces Vocational Aptitude Battery (ASVAB) composite score requirements.

INTRODUCTION

The Air Force accesses, trains, and separates thousands of young men and women each year. Recruiting goals are established based upon the projections for retention and force level requirements. The difficulty of reaching Air Force recruiting goals is reflected in changes in the recruiting budget, short-term recruiting shortfalls, and fluctuations in the overall quality of recruits. The need to anticipate problems in the accession and retention of quality personnel and the attainment of recruiting goals, particularly the level of effort required (e.g., number of production recruiters), is important to a cost-effective and efficient allocation of resources to recruiting programs. In addition, anticipating fluctuations in overall accession and retention quality allows personnel managers to adjust personnel flows into career fields internally through programs such as cross-training. Such internal adjustments minimize the short-term and long-

term effect of quality fluctuations on the mission readiness of the total force. Thus, there is great need for a model which can address the impact of changing demographics on the accession of potential recruits.

Managing and maintaining the enlisted force not only requires projecting future flows of personnel but also projecting the quality level of those future flows which affect the ability of the Air Force to meet short-run and long-run mission readiness. Jobs in the Air Force require a range of talents and capabilities to operate and maintain many of the technologically advanced weapon systems. Given a foreseeable decline in the qualified youth population, models to predict accession/retention flows of demographic groups are essential to efficient, cost effective management of Air Force personnel and allocation of recruiting resources.

DEMOGRAPHIC ACCESSION LITERATURE

Past and present research has used time series, cross-sectional, and pooled time series, cross-sectional data to analyze fluctuations in the quality and flow of military personnel (Saving, Battalio, DeVany, Dwyer, and Kagel, 1980; DeVany and Saving, 1982; Daula, Fagan, and Smith, 1982; Saving and Stone, 1983; Curtis, Borack, and Wax, 1987; Hosek and Peterson, 1985; Orvis, Gahart, and Hosek, 1989; Stone, Saving, Turner, Looper, and Engquist, 1991). The use of survey data as a basis for modeling the impact of demographic factors such as race, gender and education level has been limited, though often providing unique opportunities to analyze intricate questions (Daula, Fagan, and Smith, 1982; Orvis and Gahart, 1985; Orvis and Gahart, 1989; House, Saving, and Stone, 1985a; House, Saving, and Stone, 1985b).

One source of demographic and attitudinal data concerning potential accessions is the Youth Attitude Tracking Survey (YATS), performed annually for the Office of the Assistant Secretary of Defense for Force Management and Personnel. YATS provides information on the likelihood of future military service, effects of advertising and recruiting, and other characteristics and attitudes of the youth population. Combining the YATS data with Air Force personnel, economic, and personnel policy information can provide a unique opportunity to analyze and estimate conditional probabilities to enlist for various combinations of demographic groups. Additional information can be obtained from these probabilities if they are calculated at levels of qualitative/demographic disaggregation such as Air Force Qualifying Test (AFQT) mental categories, gender, and race (Saving et al., 1980).

Several studies have modeled the flow of AFQT aptitude groups into the military. Two studies which are particularly important for this analysis are the Cotterman (1986) and Goldberg and Goldberg (1988) studies. In both studies, the model estimation used pooled time series, cross-sectional monthly data, disaggregated to the state level. The Goldbergs analyzed the flow of non-prior service (NPS), male, high school diploma graduates (HSDGs), AFQT mental categories I through IIIa, IIIb, and I through IIIb enlistments (signed contracts) across all four branches of service. Separate models were estimated for each AFQT category for each service. Goldberg's dependent variable was defined as the number of enlistment contracts signed for each

service at time t in state s, divided by the population of male, high school seniors at time t in state s for the time period October 1979 through September 1987. Cotterman (1986) also estimated the flow of AFQT mental categories I through IIIa, HSDGs by service using pooled time series, cross-sectional (state level) data. Cotterman's dependent variable was defined as the number of enlistment contracts signed for each service at time t in state s, divided by the population of 17 to 21 year old males at time t in state s for the time period October 1974 through March 1981.

The enlistment rates (dependent variables) analyzed by the Goldbergs and Cotterman were similar, differing only in the assumption concerning the population from which the enlistments were drawn. The key difference between the two studies was in the estimation method: the Goldbergs used an autoregressive moving average regression method with explanatory variables, estimating each equation separately, while Cotterman selected a generalized least squares systems method, estimating the four service equations simultaneously. As shown in Table 1, the relative military to civilian pay elasticities were similar in range between the Goldbergs' and Cotterman studies but differed significantly in value by service.

Table 1. Relative Military to Civilian Wage Elasticities

Service	Army	Navy	Marine	Air Force
Goldberg	1.350	0.540	1.340	0.510
Cotterman	0.523	0.651	1.270	0.613

Dale and Gilroy (1984) also obtained similar relative wage elasticities for the Army flow of NPS male HSDGs, for AFQT mental categories I through IIIa which ranged from 0.9 to 1.7.

In past studies such as Cotterman (1986) and Goldberg and Goldberg (1988), the number of contracts was used as the numerator of the dependent variable. For this present study, the number of applicants was selected as the numerator of the dependent variable, instead of enlistments (signed contracts) as the Goldbergs and Cotterman had used, for two reasons: (1) the date of application for a prospective recruit is closer to the actual time of the decision to enlist and, thus, closer to the economic/recruitment environment which precipitated the applicant's decision to apply and (2) applicant flows are less constrained by recruiting goals and enlistment standards and, thus, are a better reflection of the effects of economic/recruitment factors on the actual flow of applicants into the MEPS.

DATA DESCRIPTION

This study used pooled time series, cross-sectional (state level) data to estimate supply equations for the rate of flow of Air Force applicants by demographic groups (gender and race) and aptitude groups (AFQT mental category). The applicant flows were defined as the number of MEPS applications at time *t* in state *s* for demographic group *i* and AFQT mental category *k* divided by the 17 to 21 year old youth population for state *s* and with demographic group. Equations were estimated for four aptitude categories (AFQT mental category I, II, IIIa, and IIIb) for each of six demographic groups: males, females, Caucasians, Blacks, others, and all (regardless of gender or race). Each equation was estimated over the January 1983 to December 1989 time period. Out-of-sample validation was done for each equation over the January 1990 to December 1990 time period. Table 2 contains definitions of the variables used for the estimations, as well as the expected sign of each variable.

Table 2. Variable Definitions

Variable Name	Variable Definition	Expected Sign
RMEPS	MEPS applicants / (17 - 21) population	n/a
RECR	Number of production recruiters	+
UEMP	Unemployment rate for 16-24 year olds	+
RLWG	Relative military to civilian wage	+
GLFY	Proximity to fiscal year accession goal	-
REZO	No contracts allowed period	-
F1BK	Recruits in DEP for next fiscal year	-
DDEP	Pay longevity change for DEP	-
*QTR**	Quarterly dummy variables	undefined
*ST**	State dummy variables	undefined

Application Rate

Data for the calculation of the application rate were obtained from the MEPS files maintained at Armstrong Laboratory, Human Resources Directorate (Brooks AFB) for the time period January 1983 through December 1990. The dependent variable was defined as the ratio of the number of Air Force applicants arriving at the MEPS monthly by state, by the earliest MEPS application date, to the 17 to 21 year old noninstitutionalized population by state with a high

school diploma and not in college. The population data were obtained from the Bureau of the Census.

Records for MEPS applicants often occur more than once in the historical MEPS files as applicants reapply for entry into the Air Force, retake the ASVAB test or retake the physical examination. This analysis made each applicant unique, ignoring duplicates if the individual applied more than once. The only exception was that an individual who made a subsequent application 24 months after the previous application was considered a new applicant.

Wage and Unemployment Data

The relative military to civilian wage (*RLWG*) was calculated as the ratio of military to civilian pay over the first four years of the recruit's military service. Civilian wages were calculated from state specific, private nonagricultural wage data obtained from the Bureau of Labor Statistics (BLS). Military pay included basic pay, basic allowance for quarters (BAQ), basic allowance for subsistence (BAS), tax allowances, and promotion opportunities over four years of active duty.

Monthly unemployment rates, *UEMP* by state for 16 to 24 year olds by gender and race were also obtained from the BLS for the January 1983 to December 1990 time period. Two problems encountered with this data caused a reduction in the number of states for which application rates for the Black and other racial groups could be estimated: (1) unemployment rates for Black and other youths were missing in the Bureau of Labor Statistics (BLS) data for 10% or more of the time periods for many of the states, as well as exhibiting erratic variations due to small labor force populations numbers in these states, and (2) the number of applications for Blacks and others within AFQT mental categories from the states (with unemployment problems) was zero for many of the time periods and small in many of the other time periods. Thus, twenty-five states were included for Blacks, while only eight states were included for the other category.

Mean values and standard deviations for *RLWG* and *UEMP* are provided in Table 3 for each demographic group. Sample size and number of states available for each demographic group are also provided in Table 3. States available for Blacks included: AL, AR, CA, DC, DE, FL, GA, IL, LA, MA, MD, MI, MO, MS, NJ, NV, NY, NC, OH, OK, PA, SC, TN, TX, and VA. States available for the other category included: AK, CA, HI, MT, NM, NY, OK, and SD.

Recruiting Data

In order to obtain monthly, state level recruiting data, distributions were performed on quarterly snapshots of the Uniform Airman Reports from December 1982 to December 1990. Two fields were used to identify the recruiters: ASSIGNMENT(ASGT)-CURRENT-COUNTRY/STATE and Duty AFSC (Air Force Specialty Code). A distribution on ASGT-CURRENT-COUNTRY/STATE was performed across all records for which the Duty AFSC (5-digit level) was equal to 99500, the code identifying a recruiter. The ASGT-CURRENT-COUNTRY/STATE field provided the number of the recruiters by state, ***RECR***. Total recruiter

numbers were comparable to figures provided by Air Force Recruiting Services for production recruiters. Mean values and standard deviations for ***RECR*** by demographic group are provided in Table 3.

Table 3. Means (standard deviations) of Explanatory Variables

Demographic Group	Unemployment (UEMP)	Relative Wage (RLWG)	Recruiter (RECR)	Sample Size No. of states
Males	13.56 (6.00)	1.03 (0.14)	56.19 (62.23)	4284 (51)
Females	10.73 (4.39)	1.03 (0.14)	56.19 (62.23)	4284 (51)
Caucasians	10.21 (3.94)	1.03 (0.14)	56.19 (62.23)	4284 (51)
Blacks	24.95 (10.25)	1.03 (0.15)	87.24 (74.97)	2100 (25)
Others	20.68 (8.64)	1.01 (0.15)	70.12 (69.48)	672 (8)
All	12.08 (4.45)	1.03 (0.14)	56.19 (62.23)	4284 (51)

Additional information was provided by the Air Force Recruiting Service concerning monthly recruiting goals and recruit banks, recruits in the DEP, for non-prior service (NPS) accessions for fiscal years 1982 through 1990. These data were used to form the variables ***GLFY*** and ***F1BK***. ***GLFY*** was calculated to account for adjustments by recruiters in the recruiting of NPS accessions made as the Air Force comes closer to meeting its fiscal year NPS accession goal. ***GLFY*** was calculated as the number of recruits in the DEP for the present month relative to the number of enlistments who entered the Air Force in this fiscal year as of the end of the previous month:

$$GLFY = \frac{FYBANK}{[FYGOAL-YTDEAD(-1)]} \tag{1}$$

where

FYBANK - number of recruits in the present fiscal year's bank (the assigned active duty dates are in the present fiscal year), or DEP, for the present month

FYGOAL - recruiting goal for the present fiscal year, and

YTDEAD(-1) - total number of enlistments for the present fiscal year through the preceding month with active duty dates (contracts).

The variable ***F1BK*** which represents the number of recruits in the DEP for the "next" fiscal

year was calculated to attempt to capture the effects of recruiters "stockpiling" recruits for the next fiscal year.

$$F1BK = TOTBK - FYBANK \tag{2}$$

where

TOTBK - total number of recruits in the bank for the present month.

Mean values and standard deviations for *GLFY* and *F1BK* are provided in Table 4.

Table 4. Means (standard deviations) of Other Variables

Variable	Mean (std. dev.)
GLFY	0.59 (0.21)
F1BK	9635.70 (9596.84)
REZO	0.02 (0.15)
DDEP	0.65 (0.48)
QTR1	0.25 (0.43)
QTR3	0.25 (0.43)
QTR4	0,25 (0.43)

Binary Variables

REZO is a binary variable included in the estimation to account for the three month time period during November 1989 to January 1990 (*REZO* = 1). During this time period recruiters were not permitted to sign contracts with recruits due to the large force drawdowns required to meet end-of-fiscal-year force level requirements. Another binary variable was included, *DDEP*. This variable accounts for the change in policy which no longer allowed time in the DEP to count towards longevity pay. This change occurred in June 1985.

The time period of enlistment is represented as categorical variables (*QTR1*, *QTR3*, and *QTR4*) with QTR2 being a component of the constant term. *QTR1* represents the first quarter of the fiscal year. These time variables are present in each equation. Table 4 presents the means and standard deviations for each of these binary variables. Dummy variables are also included for each state in the estimation.

ESTIMATION OF THE DEMOGRAPHIC MODELS

Equations for four aptitude groups (AFQT mental category I, II, IIIa, and IIIb) were estimated for each of six demographic groups: males, females, Caucasians, Blacks, others, and all. Males, females, Caucasians, and all posed few data problems, but Blacks could only be estimated over 25 states and others over only 8 states.

The equations were specified as

$$RMEPS_{i,k} = \alpha_{0,i,k} + \alpha_{1,i,k}RECR + \alpha_{2,i,k}UEMP + \alpha_{3,i,k}RLWG + \alpha_{4,i,k}GLFY + \alpha_{5,i,k}REZO + \alpha_{6,i,k}F1BK + \alpha_{7,i,k}DDEP + \alpha_{8,i,k}QTR1 + \alpha_{9,i,k}QTR3 + \alpha_{10,i,k}QTR4 + \sum_{j=1}^{J}(\alpha_{(10+j),i,k}ST_{j,i,k}) \qquad (3)$$

where

$\alpha_{0,i,k}$ is the intercept term for the ith demographic group and the kth AFQT mental category,

$\alpha_{c,i,k}$ is the cth coefficient for the ith demographic group and the kth AFQT mental category,

$ST_{j,i,k}$ is the binary variable for the jth state, for the ith demographic group, and the kth AFQT mental category, and

$RMEPS_{i,k}$ is the MEPS application rate for the ith demographic group and the kth AFQT mental category.

A linear functional form was used for the estimation though other functional forms were tried. Initial estimations indicated that the equations were basically insensitive to functional form.

Males

Table 5 presents the ordinary least squares (OLS) estimates of the pooled time series, cross-sectional analysis of male MEPS applicants for the Air Force in AFQT mental categories I's, II's, IIIa's, and IIIb's over the January 1983 to December 1989 time period. The coefficients vary across AFQT mental categories with AFQT mental category I having consistently smaller coefficient values. The key variables for comparison are ***RECR***, ***UEMP***, and ***RLWG***. These variables are key because they are consistently used in other studies and allow comparison of

coefficients and elasticities across studies, and because with the exception of *GLFY* and *F1BK*, these are the only continuous independent variables in the estimated equations. Coefficients for the state binary variables have been included in the constant. *RECR* and *UEMP* were statistically significant at the 99% level across AFQT mental categories with *RLWG* statistically significant in 3 of the 4 AFQT mental categories. *RLWG* was statistically significant at the 98% level of confidence for AFQT mental category I.

Table 5. Coefficients for Males by AFQT Categories

	AFQT I	AFQT II	AFQT IIIa	AFQT IIIb
CONS	-0.0748	-0.8438	-0.9073	-0.8837
RECR	0.0021**	0.0148**	0.0083**	0.0112**
UEMP	0.0013**	0.0140**	0.0076**	0.0078**
RLWG	0.1170*	1.2933**	1.0969**	0.9347**
GLFY	0.0702**	0.3836**	0.1929**	0.3010**
REZO	-0.0737**	-0.5354**	-0.4074**	-0.4613**
F1BK	0.0032**	0.0121**	0.0052**	0.0122**
DDEP	0.0123**	-0.0120	0.0488**	0.0413**
QTR1	-0.0003	-0.0565*	0.0130	0.0452*
QTR3	-0.0455**	-0.2658**	-0.1126**	-0.1517**
QTR4	-0.0465**	-0.1274*	-0.0191	-0.0886*
No. of obs	4284	4284	4284	4284
F(60,4223)	14.82	48.78	43.77	57.85
R^2	0.174	0.409	0.383	0.451
RMSE (In-sample)	0.108	0.429	0.290	0.339
RMSE (Out-of-sample)	0.118	0.444	0.296	0.383

** $p < .01$
* $p < .05$

The largest effect of ***RECR*** on the flow of MEPS applicants occurred for AFQT mental category II. The coefficient of 0.0148 means that an increase of 1 recruiter will increase the application rate of AFQT mental category II by 0.0148 or approximately 625 additional AFQT mental category II applicants (0.0148 times the average male population, 42,248.41 in thousands, over the estimation time period). The largest coefficient for ***UEMP*** was also for AFQT mental category II's, 0.0140. This coefficient value implies that if unemployment declines by 0.5 percentage points, then the application rate for AFQT mental category II's will decline by 0.0070 or approximately 296 fewer AFQT mental category II's will apply to the Air Force.

The largest coefficient for ***RLWG*** was for AFQT mental category II's, 1.2933. This coefficient value implies that if the relative military to civilian wage declines by 0.05 points, then the application rate for AFQT mental category II's will decline by 0.0647 (1.2933 times 0.05) or approximately 2,732 fewer male AFQT mental category II's will apply to the Air Force. The mean value for ***RLWG*** over the estimation time period was 1.0276 with a standard deviation of 0.1364. This results in a relative wage elasticity of 1.062. The elasticity is defined as (Becker, 1971)

$$elasticity = Coefficient \times \left(\frac{independent\,variable\,mean}{dependent\,variable\,mean}\right) \tag{4}$$

which means the calculation for the relative wage elasticity for AFQT mental category II's is equal to

$$elasticity_{RLWG} = 1.2933 \times \left(\frac{1.0276}{1.2513}\right) = 1.062 \tag{5}$$

The wage elasticities for AFQT mental categories I, IIIa, and IIIb are 0.792, 1.504, and 1.146, respectively. These elasticities are similar in range of value to the elasticities reported in Table 1 (Cotterman, 1986 and Goldberg and Goldberg, 1988).

Females

Table 6 presents the OLS estimates of female MEPS applicants. The coefficients vary across AFQT mental categories with AFQT mental category I, once again, having consistently smaller coefficient values. The magnitude of the effects of economic and recruiting factors on the decision of AFQT mental category I's to join the Air Force relative to the other AFQT mental categories is not unexpected. AFQT mental category I's would be expected to have the highest opportunity cost (e.g., more opportunity for employment or other endeavors outside of the Air Force) of the AFQT mental categories, especially with respect to attending college.

Table 6. Coefficients for Females by AFQT Categories

	AFQT I	AFQT II	AFQT IIIa	AFQT IIIb
CONS	-0.0722	-0.4809	-0.3857	-0.3475
RECR	0.0002	0.0027**	0.0017**	0.0020**
UEMP	0.0007**	0.0024**	0.0027**	0.0024**
RLWG	0.0607**	0.5822**	0.4348**	0.3993**
GLFY	0.0211**	0.1140**	0.0436**	0.0899**
REZO	-0.0139**	-0.1332**	-0.1093**	-0.1047**
F1BK	0.0010**	0.0034**	0.0000	0.0021**
DDEP	0.0014	0.0049	0.0287**	0.0266**
QTR1	0.0080**	0.0086	-0.0048	-0.0094
QTR3	-0.0087**	-0.0415**	-0.0143	-0.0335**
QTR4	-0.0082	-0.0207	0.0124	-0.0143
No. of obs	4284	4284	4284	4284
F(60,4223)	6.49	33.76	26.73	30.90
R^2	0.084	0.324	0.275	0.305
RMSE (In-sample)	0.045	0.153	0.117	0.122
RMSE (Out-of-sample)	0.034	0.143	0.124	0.126

** $p < .01$
* $p < .05$

UEMP and ***RLWG*** were statistically significant at the 99% level across all AFQT mental categories with ***RECR*** statistically significant in 3 of the 4 AFQT mental categories. ***RECR*** was not statistically significant at the 90% level of confidence for AFQT mental category I. The largest effects of changes in ***RECR***, ***UEMP***, and ***RLWG*** are consistently exhibited by AFQT mental category II, as was the case for the males. The coefficient of 0.0027 for ***RECR*** for AFQT mental category II is approximately 5.5 times smaller for females than for males. This means that an increase of 1 recruiter will increase the application rate of female AFQT mental category II's by 0.0027 or approximately 154 additional female AFQT mental category II applicants (0.0027 times the average female population, 56,938.46 in thousands, over the estimation time period), compared to 625 additional male AFQT mental category II applicants from a 1 recruiter increase, suggesting recruiters have a greater impact upon the enlistment decisions of male applicants compared to female applicants.

The coefficient for ***UEMP*** for AFQT mental category IIIa, 0.0027, implies that if unemployment declines by 0.5 percentage points, then the application rate for AFQT mental category IIIa's will decline by 0.001 or approximately 77 fewer female AFQT mental category IIIa's will apply to the Air Force. AFQT mental categories II and IIIb had the same value for the ***UEMP*** coefficient, 0.0024, which is not statistically different from the ***UEMP*** coefficient for AFQT mental category IIIa.

The coefficient for ***RLWG*** for AFQT mental category II, 0.5822, implies that if the relative military to civilian wage declines by 0.05 points, then the application rate for female AFQT mental category II's will decline by 0.0029 (0.5822 times 0.05) or approximately 166 fewer female AFQT mental category II's will apply to the Air Force. The relative wage elasticity for AFQT mental category II females of 1.984, is approximately 1.87 times as large as the relative wage elasticity for male AFQT mental category II's. The wage elasticities for female AFQT mental categories I's, IIIa's, and IIIb's are 2.012, 2.131, and 1.783, respectively. These elasticities are generally higher than the elasticities presented for males. This implies that for any AFQT category, females tend to be more responsive to changes in relative military to civilian wages than males, possibly owing to the fewer realized employment opportunities of female youths compared to male youths.

Caucasians

Table 7 presents the OLS estimates for Caucasian MEPS applicants. The coefficients vary across AFQT categories with AFQT mental category I, once again, having consistently smaller coefficient values. ***UEMP*** and ***RECR*** were statistically significant at the 99% level across AFQT mental categories, ***RLWG*** was statistically significant in all of the AFQT mental categories. The largest effects of changes in ***RECR***, ***UEMP***, and ***RLWG*** were consistently for AFQT mental category II, as was the case for the males and females.

The coefficient of 0.0080 for ***RECR*** for AFQT mental category II means that an increase of 1 recruiter will increase the application rate of Caucasian AFQT mental category II's by 0.0080 or approximately 668 additional Caucasian AFQT mental category II applicants (0.0080 times the average Caucasian population, 83,560.18 in thousands, over the estimation time period). The coefficient for ***UEMP*** for AFQT mental category II, 0.0131, implies that if unemployment declines by 0.5 percentage points, then the application rate for AFQT mental category II's will decline by 0.0065 or approximately 547 fewer Caucasian AFQT mental category II's will apply to the Air Force.

The coefficient for ***RLWG*** for AFQT mental category II of 0.6607, implies that if the relative military to civilian wage were to decline by 0.05 points, then the application rate for Caucasian AFQT mental category II's would decline by 0.0330 (0.6607 times 0.05) or approximately 2,760 fewer Caucasian AFQT mental category II's will apply to the Air Force. The relative wage elasticity for AFQT mental category II Caucasians was calculated to be 0.926. The wage elasticities for Caucasian AFQT mental categories I's, IIIa's, and IIIb's were 0.882, 1.338, and 0.717, respectively.

Table 7. Coefficients for Caucasians by AFQT Categories

	AFQT I	AFQT II	AFQT IIIa	AFQT IIIb
CONS	-0.0618	-0.3938	-0.3644	-0.1263
RECR	0.0012**	0.0080**	0.0039**	0.0045**
UEMP	0.0013**	0.0131**	0.0060**	0.0055**
RLWG	0.0784**	0.6607**	0.5316**	0.2827**
GLFY	0.0426**	0.1987**	0.0581**	0.0883**
REZO	-0.0468**	-0.3395**	-0.2288**	-0.2332**
F1BK	0.0018**	0.0046**	-0.0002	0.0019
DDEP	0.0028	-0.0177*	0.0245**	0.0242**
QTR1	0.0048	-0.0283	-0.0058	-0.0034
QTR3	-0.0271**	-0.1437**	-0.0529**	-0.0719**
QTR4	-0.0241**	-0.0457	0.0183	-0.0098
No. of obs	4284	4284	4284	4284
F(60,4223)	14.24	58.92	56.57	64.79
R^2	0.168	0.456	0.446	0.479
RMSE (In-sample)	0.061	0.241	0.152	0.159
RMSE (Out-of-sample)	0.059	0.263	0.162	0.190

** $p < .01$
* $p < .05$

Blacks

Table 8 presents the OLS estimates of Black MEPS applicants for the Air Force. The coefficients vary across AFQT mental categories with AFQT mental category I, once again, having consistently smaller coefficient values. *RECR* is statistically significant at the 99% level of confidence for AFQT mental categories II, IIIa, and IIIb, while AFQT mental category I exhibits statistical significance at the 92% level of confidence. *UEMP* is statistically significant at the 99% level of confidence for only one AFQT mental category, IIIb, while AFQT mental category IIIa exhibits statistical significance at the 92% level of confidence. AFQT mental categories I and II had statistically insignificant coefficients for *UEMP*. *RLWG* is statistically significant at the 99% level of confidence for AFQT mental categories II and IIIa, while slightly less than a 90% level of confidence for AFQT mental categories I and IIIb.

Table 8. Coefficients for Blacks by AFQT Categories

	AFQT I	AFQT II	AFQT IIIa	AFQT IIIb
CONS	-0.0546	-0.8966	-0.7264	-0.5376
RECR	0.0003	0.0055**	0.0062**	0.0124**
UEMP	-0.0001	0.0001	0.0013	0.0031**
RLWG	0.0493	1.0488**	0.8445**	0.5756
GLFY	0.0021	0.0719	0.1727**	0.4255**
REZO	-0.0148**	-0.2184**	-0.2756**	-0.4608**
F1BK	0.0004	0.0015	0.0061*	0.0125**
DDEP	0.0032	-0.0224*	0.0314*	0.0127
QTR1	0.0047	-0.0069	-0.0105	-0.0216
QTR3	-0.0032	-0.0246	-0.0697**	-0.1353**
QTR4	-0.0061	0.0291	-0.0497	-0.0732
No. of obs	2100	2100	2100	2100
F(34,2065)	1.19	16.10	17.30	24.71
R^2	0.019	0.210	0.222	0.289
RMSE (In-sample)	0.037	0.213	0.261	0.409
RMSE (Out-of-sample)	0.042	0.223	0.231	0.435

** $p < .01$
* $p < .05$

The largest coefficient for ***RECR*** occurs for AFQT mental category IIIb, 0.0124, which implies that an increase of 1 recruiter will increase the application rate of Black AFQT mental category IIIb by 0.0124, or approximately 335 additional Black AFQT mental category IIIb applicants (0.0124 times the average Black population, 27,046.98 in thousands, over the estimation time period). The largest coefficient for ***UEMP*** is for AFQT mental category IIIb, 0.0031, which implies that if unemployment declines by 0.5 percentage points, then the application rate for AFQT mental category IIIb will decline by 0.0016, or approximately 42 fewer Black AFQT mental category IIIb will apply to the Air Force.

The largest coefficient for ***RLWG*** is for AFQT mental category II, 1.0488. This coefficient implies that if the relative military to civilian wage declines by 0.05 points, then the application rate for Black AFQT mental category II's will decline by 0.0524 (1.0488 times 0.05), or approximately 1,418 fewer Black AFQT mental category II's will apply to the Air Force. The coefficient for ***RLWG*** and the sample means for ***RLWG*** and the dependent variable (application

rate for Black AFQT mental category II's) results in a relative wage elasticity of 2.589. The wage elasticities for Black AFQT mental categories I's, IIIa's, and IIIb's are 3.397, 1.604, and 0.643, respectively.

Others

Table 9 presents the OLS estimates of Other (non-Caucasian, non-Black) MEPS applicants for the Air Force. The coefficients vary across AFQT mental categories with AFQT mental category I, once again, having consistently smaller coefficient values. *RLWG* is statistically significant at the 99% level of confidence for AFQT mental category IIIb and at the 90% level of confidence for AFQT mental category IIIa.

Table 9. Coefficients for Others by AFQT Categories

	AFQT I	AFQT II	AFQT IIIa	AFQT IIIb
CONS	0.3015	-0.8353	-2.3262	-3.8543
RECR	-0.0016	-0.0073	0.0003	-0.0020
UEMP	-0.0013	-0.0009	0.0056	-0.0033
RLWG	-0.1935	1.1677	2.4128	3.9613**
GLFY	0.0339	0.5299	-0.2218	0.4051
REZO	0.0741	-0.5143	-0.7450*	-0.9327*
F1BK	0.0043	0.0280	0.0086	-0.0190
DDEP	0.0854**	0.9235**	0.9220**	1.1559**
QTR1	-0.0037	-0.2024	-0.3467	-0.2353
QTR3	-0.0127	-0.3655	-0.2834	0.0834
QTR4	-0.1136	-0.4211	-0.4275	0.5899*
No. of obs	672	672	672	672
F(17,654)	2.95	16.10	19.26	31.35
R^2	0.071	0.295	0.334	0.449
RMSE (In-sample)	0.334	1.377	1.424	1.562
RMSE (Out-of-sample)	0.517	1.887	1.803	1.956

** $p < .01$
* $p < .05$

The largest coefficient for *RLWG* is for AFQT mental category IIIb, 3.9613. This coefficient implies that if the relative military to civilian wage declines by 0.05 points, then the application rate for other AFQT mental category IIIb's will decline by 0.1981 (3.961295 times 0.05), or approximately 878 fewer other AFQT mental category IIIb's will apply to the Air Force (3.961295 times 0.05 times the average other population, 4433.02 in thousands, over the estimation time period).

All

Table 10 presents the OLS estimates of all (includes all gender and race groups) MEPS applicants. The coefficients vary across AFQT mental categories with AFQT mental category I, once again, displaying consistently smaller coefficient values. The magnitude of the effects of economic and recruiting factors on the decision of AFQT mental category I to join the Air Force relative to the other AFQT mental categories is not unexpected. AFQT mental category I would be expected to have the highest opportunity cost of the AFQT mental categories, especially with respect to attending college.

Table 10. Coefficients for All by AFQT Categories

	AFQT I	AFQT II	AFQT IIIa	AFQT IIIb
CONS	-0.0700	-0.6460	-0.5962	-0.5632
RECR	0.0010**	0.0075**	0.0043**	0.0057**
UEMP	0.0012**	0.0137**	0.0083**	0.0085**
RLWG	0.0803**	0.8320**	0.6665**	0.5724**
GLFY	0.0430**	0.2407**	0.1136**	0.1843**
REZO	-0.0395**	-0.3035**	-0.2343**	-0.2541**
F1BK	0.0020**	0.0072**	0.0022*	0.0063**
DDEP	0.0057**	0.0008	0.0406**	0.0368**
QTR1	0.0049	-0.0126	0.0067	0.0168
QTR3	-0.0250**	-0.1406**	-0.0569**	-0.0834**
QTR4	-0.0250**	-0.0604*	0.0040	-0.0390
No. of obs	4284	4284	4284	4284
F(60,4223)	18.80	61.43	57.61	69.57
R^2	0.211	0.466	0.450	0.497
RMSE (In-sample)	0.055	0.226	0.152	0.173
RMSE (Out-of-sample)	0.054	0.242	0.167	0.211

** $p < .01$
* $p < .05$

UEMP, ***RLWG***, and ***RECR*** were statistically significant at the 99% level across all AFQT mental categories. The largest effects of changes in ***RECR***, ***UEMP***, and ***RLWG*** are consistently exhibited by AFQT mental category II, as was the case for the males and females. The coefficient for ***RECR*** of 0.0075 means that an increase of 1 recruiter will increase the application rate of all AFQT mental category II by 0.0075 or approximately 743 additional AFQT mental category II applicants (0.0075 times the average youth population, 99,186.77 in thousands, over the estimation time period).

The coefficient for ***UEMP*** for AFQT mental category II, 0.0137, implies that if unemployment declines by 0.5 percentage points, then the application rate for AFQT mental category II will decline by 0.007 or approximately 694 fewer AFQT mental category II's will apply to the Air Force. The coefficient for ***RLWG*** for AFQT mental category II, 0.8320, implies that if the relative military to civilian wage declines by 0.05 points, then the application rate for all AFQT mental category II's will decline by 0.0416 (0.8320 times 0.05) or approximately 4,126 fewer AFQT mental category II's will apply to the Air Force.

Elasticities

The elasticities with respect to recruiters (***RECR***), unemployment (***UEMP***), and relative military to civilian wages (***RLWG***) vary significantly between demographic groups and aptitude groups within demographic groups. Tables 11, 12, and 13 present the elasticities for ***RLWG***, ***UEMP***, and ***RECR***, respectively. The elasticities are calculated using Equation 4.

Relative Military to Civilian Wage Elasticity. The relative wage elasticities (***RLWG***) presented in Table 11, reveal that Blacks tend to show the highest relative wage elasticity. These higher wage elasticities suggest that Black youths have fewer realized employment opportunities, and are therefore more sensitive to changes in military compensation relative to civilian compensation compared to Caucasian youths. Females had higher wage relative wage elasticities when compared to males. This also suggests that female youths have fewer realized employment opportunities when compared to male youths, thus making them more sensitive to changes in relative military to civilian compensation.

AFQT mental category IIIb's tend to have lower relative wage elasticities across all demographic groups. The low relative wage elasticities for AFQT mental category IIIb's could be the result of recruiters discouraging potential low aptitude applicants from advancing to the MEPS stage of the application process. This implies that the recruiter is able to assess aptitude on the basis of other information besides actual AFQT scores.

Unemployment Elasticity. The unemployment elasticities displayed a similar range of variation across demographic and aptitude groups as did the relative military to civilian wage elasticities (Table 12). The unemployment elasticities for Caucasian youths and male youths suggest that on average Caucasians and male youths are more responsive to changes in the unemployment rate. Males have historically shown a higher propensity to apply for military service than females, and thus when the unemployment rate increases, males tend to have a

larger increase in their application rates for military service compared to females. The relatively fewer job opportunities for females in the military also causes the female application rate to be less responsive to changes in the unemployment rate compared to males.

Table 11. Relative Wage Elasticities for Demographic and Aptitude Groups

Demographic Group	AFQT Cat I	AFQT Cat II	AFQT Cat IIIa	AFQT Cat IIIb
Males	0.792	1.062	1.504	1.146
Females	2.012	1.984	2.131	1.783
Caucasians	0.882	0.926	1.338	0.717
Blacks	3.397	2.588	1.604	0.643
Others	-1.646[a]	0.769[a]	1.653	2.009
All	0.999	1.210	1.559	1.205

Note: Values annotated by [a] are statistically insignificant (below the 90% level of confidence)

Table 12. Unemployment Elasticities for Demographic and Aptitude Groups

Demographic Group	AFQT Cat I	AFQT Cat II	AFQT Cat IIIa	AFQT Cat IIIb
Males	0.116	0.152	0.137	0.126
Females	0.250	0.087	0.140	0.113
Caucasians	0.146	0.183	0.151	0.138
Blacks	-0.166[a]	0.006[a]	0.060	0.085
Others	-0.228[a]	-0.012[a]	0.078[a]	-0.034[a]
All	0.175	0.234	0.227	0.210

Note: Values annotated by [a] are statistically insignificant (below the 90% level of confidence)

Recruiter Elasticity. The recruiter elasticities presented in Table 13 also vary across demographic and aptitude groups but not with the level of variation displayed by the relative military to civilian elasticities and the unemployment elasticities. With the exception of females, the recruiter elasticities across all demographic groups tend to suggest that the impact of a recruiter is the largest for higher aptitude (AFQT mental category I) compared to lower aptitude (AFQT mental categories II and IIIa) youths.

Table 13. Recruiter Elasticities for Demographic and Aptitude Groups

Demographic Group	AFQT Cat I	AFQT Cat II	AFQT Cat IIIa	AFQT Cat IIIb
Males	0.781	0.665	0.618	0.748
Females	0.375*	0.507	0.453	0.489
Caucasians	0.737	0.614	0.540	0.619
Blacks	1.745	1.153	1.000	1.176
Others	-0.950*	-0.333*	0.014*	-0.070*
All	0.705	0.596	0.544	0.653

*Note: Values annotated by * are statistically insignificant (below the 90% level of confidence)*

Explanatory Credibility of Equations

The R^2s were strong for males and Caucasians in AFQT mental categories II, IIIa, and IIIb, as shown in Table 14. All equations were statistically significant (F-value) with the exception of Black/AFQT mental category I. AFQT mental category I consistently had the lowest R^2s across demographic groups. AFQT mental category I also had the smallest number of applicants. For example, the mean number of applicants across states presented in Table 15 for males, AFQT mental category I was 5.9, while the means for males, AFQT mental categories II, IIIa, and IIIb were 49.1, 29.3, and 33.2, respectively. Similar patterns were exhibited by females (1.5 for AFQT Category I), Caucasians (7.0 for AFQT mental category I), and Blacks (0.4 for AFQT mental category I). Blacks equations, in general, had low R^2s (Table 14), but they also had low application rates, as well as having sufficient data for analysis of only 25 states.

An out-of-sample projection was made for the calendar year 1990 and compared with actual application rates. The root-mean-square errors (RMSE) are presented for both in-sample and out-of-sample projections in Table 16. The out-of-sample RMSEs are only slightly larger than

their in-sample counterparts. The RMSE's for the AFQT mental category I's tend to be larger than the sample means of the dependent variables (Stone et al., 1991).

Table 14. R^2's for Equations

Aptitude/ Demographic Group	AFQT Category 1	AFQT Category II	AFQT Category IIIa	AFQT Category IIIb
Males	0.174	0.409	0.383	0.451
Females	0.084	0.324	0.275	0.265
Caucasians	0.168	0.456	0.446	0.479
Blacks	0.019[a]	0.210	0.222	0.289
Others	0.071	0.295	0.334	0.449
All	0.211	0.466	0.450	0.497

Note: Value annotated by [a] is statistically insignificant (below the 90% level of confidence)

Table 15. Sample Means for Application Numbers

Aptitude/ Demographic Group	AFQT Category I	AFQT Category II	AFQT Category IIIa	AFQT Category IIIb
Males	5.9	49.1	29.3	33.2
Females	1.5	15.2	10.9	12.3
Caucasians	7.0	56.8	31.2	30.9
Blacks	0.4	11.1	14.2	24.3
Others	0.6	7.3	6.5	8.7
All	7.4	64.3	40.1	45.6

Table 16. In-Sample and Out-of-Sample RMSEs

Aptitude/ Demographic Group	AFQT Category I	AFQT Category II	AFQT Category IIIa	AFQT Category IIIb
Males - In	0.108	0.429	0.290	0.339
Males - Out	0.118	0.444	0.296	0.383
Mean*	0.152	1.251	0.750	0.838
Females - In	0.045	0.153	0.117	0.122
Females - Out	0.034	0.143	0.124	0.126
Mean	0.030	0.301	0.210	0.230
Caucasians - In	0.061	0.241	0.152	0.159
Caucasians - Out	0.059	0.263	0.162	0.190
Mean	0.091	0.733	0.408	0.405
Blacks - In	0.037	0.213	0.261	0.409
Blacks - Out	0.042	0.223	0.231	0.435
Mean	0.015	0.416	0.541	0.920
Others - In	0.334	1.377	1.424	1.562
Others - Out	0.517	1.887	1.803	1.956
Mean	0.119	1.540	1.481	2.000
All - In	0.055	0.226	0.152	0.173
All - Out	0.054	0.242	0.167	0.211
Mean	0.083	0.706	0.439	0.488

* *Sample mean of the dependent variable.*

Summary of Estimation Results

The coefficients for number of recruiters (*RECR*), unemployment (*UEMP*), and relative military to civilian wage (*RLWG*) were statistically significant at the 99% level of confidence for

males (relative military to civilian wage, AFQT mental category I - 98%), females (number of recruiters, AFQT mental category I - insignificant), and Caucasians. The coefficients for Blacks were insignificant for recruiters for AFQT mental category I, for unemployment AFQT categories I, II, and IIIa, and for relative military to civilian wage in the case of AFQT mental categories I and IIIb.

The R^2s were strong for males and Caucasians, AFQT mental category II's IIIa's, and IIIb's, Table 14. All equations were statistically significant (F-value) with the exception of black/AFQT mental category I's. AFQT mental category I's consistently had the lowest R^2s across demographic groups. The out-of-sample RMSEs, for most demographic groups, are only slightly larger than their in-sample counterparts. The RMSE's for the AFQT mental category I's tend to be larger than the sample means of the dependent variables.

The relative military to civilian pay elasticities were similar in range to other studies, but differed significantly across demographic and aptitude groups. On average, a 1% increase in the relative military to civilian wage will increase the rate of application by approximately 1.00% for AFQT mental category I's, 1.21% for AFQT mental category II's, 1.56% for AFQT mental category IIIa's, 1.21% for AFQT mental category IIIb's.

The unemployment elasticities also varied significantly across demographic and aptitude groups. On average, a 1% increase in the unemployment rate will increase the rate of application by approximately 0.18% for AFQT mental category I's, 0.23% for AFQT mental category II's, 0.23% for AFQT mental category IIIa's, 0.21% for AFQT mental category IIIb's.

The recruiter elasticities differed across demographic and aptitude groups but not with the level of variation displayed by the relative military to civilian elasticities and the unemployment elasticities. On average, a 1% increase in the number of recruiters will increase the rate of application by approximately 0.71% for AFQT mental category I's, 0.60% for AFQT mental category II's, 0.54% for AFQT mental category IIIa's, 0.65% for AFQT mental category IIIb's.

IMPLEMENTATION OF THE DEMOGRAPHIC MODELS INTO AAPS

The Airman Applicant Prediction System (AAPS) is a user friendly, menu-driven software package which provides the user with the ability to analyze the rate of flow of various demographic groups into the MEPS for Air Force entry (Fast, Stone, Turner, Looper, and Engquist, 1991). The applicant equations developed in this study were implemented into AAPS to improve the predictability of AAPS and extend the level of analysis in AAPS from aggregate to the state/region level. AAPS begins with a user specified available (A) youth population (e.g., 17 to 21 year old male Caucasians) and proceeds to determine the numbers of the youth population that are military available (MA), interested military available (IMA), interested qualified military available (IQMA), and MAGE stratification of the IQMA population.

Military Available

In AAPS, the population data for each state is maintained as a proportion of the total population across states in order to minimize internal memory requirements. Thus, AAPS begins by determining the proportion of the total population for the jth state, P_j, and the total population N. Of course, there will be a population N for each projection year, 1995 to 2010. The following discussion is for a single projection year but is extendable for multiple projection years. Population projections were obtained from the Bureau of the Census for 16 to 26 year olds by race and gender for the time period 1988 to 2010.

The analysis begins with the user selected available population as defined by gender, race, and age which is equal to the summation of the state level available population to produce N. The next step in the analysis is the estimation of the portion of the available population which is institutionalized. The proportion of any selected population which is institutionalized is assumed to be equal to a constant. The level of the institutionalized population can be modified by the user. The proportion of the available population which is institutionalized in each state, P_I times P_j times N, redefines N to be

$$N \times (1-P_I) = N^* \qquad (6)$$

where

N^* - number of the non-institutionalized population and

P_I - proportion of the available population which is institutionalized (Spencer, 1989).

The next step in the analysis is to define the number of high school diploma graduates in the population. This is defined as the proportion of non-institutionalized population in each state, j, expected to receive degrees times the non-institutionalized population, N^*. To determine the number of high school graduates for each state, $HSDG_j$, then:

$$H_j \times P_j \times N^* = HSDG_j \qquad (7)$$

where

H_j - proportion of high school degrees conferred for state j and

P_j - proportion for state j of the total available population.

Proportions of each states population with high school degrees were obtained from the U.S. Department of Education, National Center for Education Statistics (based on Fall 1986 enrollments). Thus, the state proportions which must be carried forward to the next step in the analysis of the population are

$$P_{j,HSDG} = \frac{HSDG_j}{\sum_{j=1}^{J} HSDG_j} \tag{8}$$

where the denominator of Equation 8 is the number of high school graduates.

The number of the selected non-institutionalized population who are already in the service is calculated next. The number of armed service members is equal to the proportion of the non-institutionalized population of each state in-service times the proportion of population in each state, j, times the non-institutionalized population, N^*. This can be expressed as

$$I_j \times P_j \times N^* = SVC_j \tag{9}$$

where

I_j - proportion of in-service members in the non-institutionalized population by state j and

SVC_j - number of armed service members for each state.

Proportions of the non-institutionalized population in-service by state were obtained from Bureau of the Census projections of resident Armed Forces populations for 1988 to 2010. Thus, the state proportions which must be carried forward to the next step in the analysis are

$$P_{j,SVC} = \frac{SVC_j}{\sum_{j=1}^{J} SVC_j} \tag{10}$$

where the denominator of Equation 10 is the number of people already members of the Armed Forces.

The number of the non-institutionalized population who have prior military service is the next calculation. The number of prior service members in the non-institutionalized population is equal to the proportion of prior service in the population times the proportion of the non-institutionalized population of each state times the non-institutionalized population. The proportion of prior service in the population is assumed to be constant across states, thus, varying by a constant proportion of the state population. This can be expressed as

$$PS \times P_j \times N^* = PRS_j \tag{11}$$

where

PS - proportion of prior service members in the non-institutionalized population, N^*, and

PRS_j - number of prior service members for each state.

The proportions for the prior service population were based on a study by Verdugo and Berliant (1988). The state proportions which must be carried forward in the analysis become

$$P_{j,PRS} = \frac{PRS_j}{\sum_{j=1}^{J} PRS_j} \tag{12}$$

where the denominator in Equation 12 is the number of prior service members for the selected population.

The number of college students in the population is calculated next. The number of college students in the non-institutionalized population is equal to the proportion of college students in the population of state *j* times the proportion of the non-institutionalized population of each state times the non-institutionalized population which can be expressed as

$$C \times P_j \times N^* = COL_j \tag{13}$$

where

C - proportion of college students in the non-institutionalized population (Verdugo and Berliant, 1988), N^*, and

COL_j - number of college students for each state.

The state proportions which must be carried forward in the analysis are

$$P_{j,COL} = \frac{COL_j}{\sum_{j=1}^{J} COL_j} \tag{14}$$

where the denominator of Equation 14 is the number of college students in the selected non-institutionalized population.

The calculation of the *MA* population must exclude the institutionalized population, non-high school graduates, number of active armed service members in the population, number of prior service members in the population, and number of college students in the population. Excluding the number of non-high school graduates from the population is particularly relevant for the Air

Force, though other branches of the Department of Defense (DoD) may consider accessing non-high school graduates. The exclusion of non-high school graduates is also relevant for the present recruiting environment in which the demand for accessions has declined significantly due to force downsizing. Thus, the *MA* for state *j* is equal to

$$\begin{aligned} MA_j = & (P_{j,HSDG} \times N^*) - (P_{j,SVC} \times N^*) \\ & - (P_{j,PRS} \times N^*) - (P_{j,COL} \times N^*) \\ & + (P_{j,PRS} \times P_{j,COL} \times N^*) \end{aligned} \tag{15}$$

To continue the analysis of the selected population, the state proportions which must be carried forward to the next step in the analysis are

$$P_{j,MA} = \frac{MA_j}{\sum_{j=1}^{J} MA_j} \tag{16}$$

where the denominator of Equation 16 is the number for military available and $P_{j,MA}$, is the proportion which will be used continue to the analysis of *IMA*. The original P_j will no longer be used beyond this point of the population analysis.

Interested Military Available

The calculation of the Interested Military Available (*IMA*) uses the *MA* population to determine the number of interested AFQT mental category I's, II's, IIIa's, and IIIb's in the *MA* population. The empirical results from the Estimation of Demographic Models section are used to estimate the number interested in each of the AFQT mental categories. For example, the number of interested military available AFQT mental category I's in the *MA* population is equal to the proportion of AFQT mental category I's in state *j* of the population (estimated from the empirical results of the previous section) times the proportion of the *MA* population in state *j* times the *MA* population. The proportion of AFQT mental category *k* applicants in state *j*, $P_{j,k}$ can be expressed as

$$\begin{aligned} P_{j,k} = & \alpha_{0,j,k} + \alpha_{1,j,k} RECR + \alpha_{2,j,k} UEMP + \\ & \alpha_{3,j,k} RLWG + \alpha_{4,i,k} ST_{j,k} \end{aligned} \tag{17}$$

where

$\alpha_{0,j,k}$ - intercept term for the jth state and the kth AFQT mental category from the empirical results of the estimations presented in the previous section (Equation 3). The coefficients for the variables ***GLFY***, ***REZO***, ***F1BK***, ***DDEP***, ***QTR1***, ***QTR3***, and ***QTR4***, have been included in the intercept term,

$\alpha_{c,j,k}$ - the cth coefficient for the jth state and the kth AFQT mental category from the empirical results of the estimations presented in the previous section,

$ST_{j,k}$ - binary variable for the jth state and the kth AFQT mental category, and

values for ***RECR***, ***UEMP***, and ***RLWG*** may be specified by the user. The number of interested military available (*IMA*) in the kth AFQT mental category for each state, $IMACAT_{j,k}$, can then be calculated and expressed as

$$IMACAT_{j,k} = P_{j,k} \times P_{j,MA} \times MA \tag{18}$$

where

$P_{j,k}$ - proportion of the kth AFQT category in state j of the population,
$P_{j,MA}$ - proportion of military available (MA) in state j of the MA population, and
MA is the military available population from the original selected population.

The state proportions which have been maintained to this point of the analysis are no longer required for the remaining population analysis. The number of $IMACAT_{j,k}$ collapses across states for each kth category and will be maintained for the next steps of the analysis. $IMACAT_k$ can be expressed as

$$IMACAT_k = \sum_{j=1}^{J} IMACAT_{j,k} \tag{19}$$

The calculation for AFQT mental category I's, II's, IIIa's, and IIIb's follows the same method as the calculation for AFQT mental category k. The only factor which changes is the proportion of specific AFQT mental category in state j of the population which is derived from the empirical results of the previous section.

The calculation of the total *IMA* population is equal to the sum of the calculations for AFQT mental category I's, II's, IIIa's, and IIIb's. This can be expressed as

$$IMA = IMACAT_I + IMACAT_{II} + IMACAT_{IIIa} + IMACAT_{IIIb} \tag{20}$$

or

$$IMA = \sum_{k=1}^{n} IMACAT_k \tag{21}$$

Interested Qualified Military Available

The Interested Qualified Military Available (*IQMA*) requires the exclusion of three groups from the population: those who do not meet the AFQT mental category requirements, those who are not medically and/or morally qualified, and those who do not meet the minimum enlistment standards for the Air Force based on the general (G) composite score and the sum of the four composite scores: general, mechanical (M), administrative (A), and electronic (E). For example, the Air Force presently requires that an applicant possess a G score of 60 or better and a summed composite score of 180 or better to qualify for the Air Force. This represented the minimum enlistment standards for the Air Force at the time of this study.

To determine the number of AFQT qualified in the selected population, the numbers from each AFQT mental category designated as qualified are summed together. For example, if AFQT mental category I and AFQT mental category II have been designated as qualified, then AFQT Qualified will equal the sum of the numbers for AFQT mental category I and AFQT mental category II from the *IMA* population.

The number medically and morally qualified from the *IMA* population is equal to the proportion of medically and morally qualified applied to each AFQT mental category selected as qualified. Thus, MMQ_k, the number of medically and morally qualified, can be determined for each qualified AFQT mental category k by

$$MMQ = \sum_{k=1}^{n} (MM \times IMACAT_k) \tag{22}$$

where

- MM - proportion of medically, morally qualified (AF/MPZ Special Study Team, 1985),
- $IMACAT_k$ - number of IMA population that is AFQT mental category k, and
- MMQ - medically and morally qualified population of the IMA population.

Thus, MMQ is the number of medically and morally qualified population.

The enlistment standards qualified (*ESQ*) population which meets the minimum G score and summed Composite is equal to the proportion applied to each AFQT mental category selected

as qualified. Thus, ESQ_k, the enlistment standards qualified for AFQT mental category k can be expressed as

$$ESQ = \sum_{k=1}^{n} (ESQ_k \times IMACAT_k) \tag{23}$$

where

ESQ_k - proportion of the AFQT mental category k which meets the enlistment standards of G score and Composite,

$IMACAT_k$ - number of interested military available AFQT mental category k from the *IMA* population, and

ESQ - population of AFQT mental category qualified which meets the enlistment standards of G score and summed Composite.

ESQ_k was based on matrices in which each cell of the matrix represents the proportion of the MEPS population for FY90 MEPS data which possessed those M, A, G, and E scores. For example, one of the matrix cells could represent all applicants who had an M score of 50, an A score of 80, a G score of 70, and an E score of 40. There was a matrix for each AFQT mental category (I through IIIb) and each cell of the matrix represented a decile combination of scores. In order to calculate the proportion of *ESQ* for the *k*th AFQT Category, the ratio equaled the number of applicants in the relevant cells (cells identified as qualified, meeting both the G score minimum and the summed Composite minimum) divided by total number of applicants in the *k*th matrix. For example, if the user selected AFQT mental categories I and II, the matrices for $k=1$ and $k=2$ are used to calculate the proportion of each matrix which is *ESQ*, ESQ_1 and ESQ_2.

Thus, the calculation of *IQMA* from the population of *IMA* can be expressed as

$$IQMA = \sum_{k=1}^{n} [(MM \times ESQ_k) \times IMACAT_k] \tag{24}$$

where

MM - proportion of medically, morally qualified (AF/MPZ Special Study Team, 1985),

ESQ_k - proportion of the AFQT Category k which meets the enlistment standards of G score and summed Composite,

$IMACAT_k$ - number of interested military available AFQT mental category k from the IMA population, and

IQMA - population of interested military available population which is qualified from the IMA population.

Thus, *IQMA* is the number interested qualified military available from the selected population. In addition, the number of interested military available population which is qualified from the $IMACAT_k$ population, $IQMA_k$, must be maintained for the next stage of the analysis. $IQMA_k$ is equal to

$$IQMA_k = (MM \times ESQ_k) \times IMACAT_k \tag{25}$$

The MAGE Distribution of the IQMA Population

MAGE Distribution of IQMA uses the same MAGE matrices applied in the calculation of IQMA. However, n will be calculated using the sum of the restricted cells of the matrices (restricted by the enlistment standards and by the AFQT mental categories selected)

$$IQMAMAGE = \sum_{k=1}^{n} (ESQR_k \times IMACAT_k) \tag{26}$$

where

$ESQR_k$ is the proportion of the AFQT mental category k which meets the designated MAGE standards,

$IQMA_k$ is the number of interested military available population which is qualified from the $IMACAT_k$ population, and

IQMAMAGE is the population of interested qualified military available population which meets the designated MAGE standards.

AIRMAN APPLICANT PREDICTION SYSTEM SOFTWARE

The preceding section discussed the components of the Airman Applicant Prediction System (AAPS). In this section, the mechanics of using and operating the software for AAPS will be discussed. AAPS allows a user to predict the number of qualified applicants for Air Force service from a given demographic population. The user may specify census, economic, and availability constraints within AAPS. AAPS begins with a user specified demographic population, and then determines the **available (A), military available (MA), interested military available (IMA), and interested qualified military available (IQMA)** population for the specified demographic group(s). The IQMA population may then be queried to determine the number of applicants that meet minimum ASVAB composite score requirements.

Census Constraints

AAPS first allows a user to specify the population from which a projection will be made. By specifying census constraints the user may specify a national prediction (all states), a regional prediction (all states within the specified regions), or a state prediction (any combination of

states). The user may also specify the racial and gender groups to be included in the prediction. The user may choose from Caucasians, Blacks, or others (or any combination of the three) and from males or females (or both). Population data are available for 17 to 26 year olds in each demographic group. The user may also specify the age groups to be included in the prediction. Census constraints also allow the user to specify the time period for the prediction, with the years 1995 to 2010 available. After selecting a population for the prediction, the user is ready to either change the economic or availability constraints, or to use the Forecast option to obtain the predictions.

Economic Constraints

Economic constraints allow the user to specify changes in the unemployment rate, the ratio of military to civilian wages, or the recruiting resources. Unemployment rates may be changed by state or across states, as well as by demographic groups or across demographic groups. The ratio of military to civilian wages may be changed by state or across states. Recruiting resources (number of recruiters) may also be changed by or across states. After changing the economic constraints, the user is ready to either change the availability constraints or to use the Forecast option to obtain the predictions.

Availability Constraints

Availability constraints allow the user to specify military availability constraints and qualifying availability constraints. Military availability constraints determine the proportion of the population that will be excluded from the MA population because they are institutionalized, in-service, have prior service, or are in college. The user may change the proportion of the population that are in any of these categories. The user may also specify the proportion of the IMA population that will medically and morally qualified for military service.

Qualifying availability constraints allow the user to specify enlistment qualifications. The user may determine if a high school diploma is required for applicants to be considered qualified, and may also specify the proportion of the population in each state which will have a high school diploma. The AFQT mental categories which will be considered as qualified for enlistment may also be specified (categories I, II, IIIa or IIIb). The user may also specify the minimum enlistment standards, minimum General and Composite scores, for all applicants to be considered qualified. After specifying the availability constraints, the user may then use the Forecast option to obtain the predictions.

Forecasting Predictions

The Forecast option allows the user to obtain the predictions of the A, MA, IMA, and IQMA population for the chosen demographic groups. The A population is the predicted number of youths for the chosen demographic and age groups for all specified states by year. The MA population predictions are obtained by removing the institutionalized, non-high school degree (if specified), in-service, prior service and college populations from the A population. The

empirical results of the estimations of this study are then used to predict the numbers of applicants (IMA) by AFQT mental category from the MA population. AFQT mental category, medical and moral, and enlistment standard qualifications are then applied to the IMA population in order to obtain the IQMA population. The user may then specify minimum ASVAB composite scores, mechanical (M), administrative (A), general (G), and electronic (E), required for applicants. AAPS will then predict the number of applicants meeting this minimum score requirements from the IQMA population.

The user has the option of printing any of the prediction tables or viewing graphs of the tables. The user may also save the tables created from the predictions. At this time the user may return to the census constraints and create new predictions or exit the package.

CONCLUSIONS

The Estimation of the Demographic Models section presented the results of the estimation of the state level demographic models using pooled time series, cross-sectional data. Three of the demographic groups provided models which exhibited strong statistical results considering results generally obtained from pooled time series, cross-sectional analyses and compared to previous studies by Cotterman (1986) and Goldberg and Goldberg (1988). Coefficients and their elasticities presented in Section IV are comparable to Cotterman (1986) and Goldberg and Goldberg (1988) results, though only the Goldbergs performed analysis for the Air Force.

Several key features differentiate the study presented in Section IV from previous studies. Cotterman (1986) and Goldberg and Goldberg (1988), as well as other analysts use contracts, not applicants, in the numerator of the dependent variable to represent the rate of accession. The number of contracts in a given month for the Air Force are driven primarily by recruiting goals which have been met on a monthly basis for the past several years (at least since 1983). Thus, using contracts to represent the actual flow of people seeking employment in the Air Force is modeling a constrained and predictable flow. Air Force Recruiting Service can predict with nearly 100% accuracy the number of accessions in each month of fiscal year 1992. Applicants are a much better representation of a market driven supply, affected by the normally accepted market factors of military to civilian wages, recruiters, and employment.

In addition, this study not only analyzes the flow of male high school graduates, but includes females, Caucasians, Blacks, and others. In addition, the analysis further categorizes these demographic groups by AFQT categories I, II, IIIa, and IIIb.

The specification of the equations included variables to account for recruiting effort beyond the number of production recruiters. *GLFY* represents how well the Air Force was performing relative to the fiscal year NPS accession goal. For each monthly time period, t, it represented how well the Air Force had attained its fiscal year enlistment goal through time period $t-1$. ***REZO*** was a binary variable for the three month time period during November 1989 to January 1990 (***REZO*** = 1) when recruiters were not allowed to issue contracts to recruits due to the large

force drawdowns required to meet end-of-fiscal-year force level requirements. ***F1BK*** is a variable which represents the number of recruits in the DEP for the "next" fiscal year.

Even with the specification of these other recruiting factors in the equation, the variable for the number of production recruiters was still statistically significant in 18 of the 24 equations. In addition, due to this level of detail in the equation specification, the coefficients for recruiter had a much better chance of representing the actual effect of recruiters on the application flow.

The estimation results presented in this study can be summarized with several key points. The relative military to civilian pay elasticities were similar in range to other studies, but differed significantly across demographic and aptitude groups. The unemployment elasticities also varied significantly across demographic and aptitude groups. The recruiter elasticities differed across demographic and aptitude groups but not with the level of variation displayed by the relative military to civilian elasticities and the unemployment elasticities.

Coefficients for number of recruiters (***RECR***), unemployment (***UEMP***), and relative military to civilian wage (***RLWG***) were statistically significant at the 99% level of confidence for males (relative military to civilian wage, AFQT mental category I - 98%), females (number of recruiters, AFQT mental category I - insignificant), and Caucasians. Blacks exhibited insignificance for recruiters for AFQT mental category I, for unemployment for AFQT mental categories I, II, and IIIa, and for relative military to civilian wage in the case of AFQT mental categories I and IIIb.

The R^2s for the equations were strong for males, Caucasians and all, AFQT mental category II's IIIa's, and IIIb's. All equations were statistically significant (F-value) with the exception of Black/AFQT mental category I's. AFQT mental category I's consistently exhibited the lowest R^2s across demographic groups. The out-of-sample RMSEs are only slightly larger than their in-sample counterparts. The RMSE's for the AFQT mental category I's are consistently larger than the sample means of the dependent variables. This implies that the equations did as well predicting in-sample as they did out-of-sample.

The results of the estimation of this study were implemented in the Airman Applicant Prediction System (AAPS) software. AAPS is user-friendly, menu-driven, PC compatible software package which may be used to predict the applicant flow of selected demographic groups at the national, regional, or state level. The estimated coefficients of the equations are used to predict the number of a military available (MA) population that would be interested in applying for Air Force service by AFQT mental category.

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APPENDIX

The state level population projections within the Airman Applicant Prediction System (AAPS) must be periodically updated. AAPS currently contains population projections for the year 1988 through 2010. These population projections were obtained from the United States Department of Commerce, Bureau of the Census, and are consistent with those published in "Projections of the Population of States by Age, Sex, and Race: 1989 to 2010", Current Population Reports, Series P-25, No. 1053.

Updated population projections should also be obtained from the Bureau of Census. Projections of state populations by single years of age, sex and race which are consistent with those published in the Current Population Reports, Series P-25, No. 1053 should be requested from:

Mr. Larry Sink
Statistical Information Staff
Population Division
Bureau of the Census
Washington, D.C. 20233
(301) 763-1902

These data are available on diskette for purchase.

AAPS contains population projections from projection series C for the ages 16 to 26 years of age. To update the population file for AAPS, a file must be created which contains the concatenated state population files for all 51 states obtained from the Bureau of the Census. This file should be in the following format:

Variable	Type	Length	Values
State	char	2	state postal codes
Year	num	4	19xx - 20xx
Race	num	1	1 = caucasians
			2 = blacks
			3 = other
Sex	num	1	1 = males
			2 = females
Pop16	num	6	population age 16
Pop17	num	6	population age 17
.	.	.	.
.	.	.	.
Pop26	num	6	population age 26

This file should be named **STATE.DAT** and should be used to replace the current **STATE.DAT** file presently used by AAPS. The starting and ending years of the population projections must also then be changed within AAPS. The years must be changed within the **BROBJ.PAS** file. The variable ***MINYEAR*** must be set equal to the year of the first population projection within the **STATE.DAT** file. The variable ***MAXYEAR*** must be set equal to the year of the last population projection within the **STATE.DAT** file. AAPS will now predict using the new population projections.